

ORIGINAL CONTRIBUTION

Association Between Obesity and Hyperlipidemia Among Children

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Background: This study was undertaken to show the association between obesity and hyperlipidemia among the children.

Methods: In March 2000, while conducting a comprehensive health examination, we analyzed 2011 children from the first grade of primary schools in Taichung City in Taiwan. To study the association between obesity and hyperlipidemia, the t test, chi-square analysis, and multivariate logistic regression were used.

Results: There were 1057 boys (52.56 percent) and 954 girls (47.44 percent). The mean age was 7.27 ± 0.46 years. The proportion of overweight was 11.07 percent in boys and 11.64 percent in girls. The proportion of obesity was 14.19 percent in boys and 12.89 percent in girls. After controlling the other covariates, the multivariate logistic regression analysis showed that overweight was associated with a low level of high density lipoprotein cholesterol. Obesity was associated with hypertriglyceridemia, a high level of low density lipoprotein cholesterol, and a low level of high density lipoprotein cholesterol.

Conclusions: Our findings disclosed that the prevalence of overweight and obesity was high in childhood. Early intervention to control and prevent childhood obesity might be warranted. Obesity was associated with hyperlipidemia in children. A wide-scale survey will be suggested in the future to establish causal-effect issues between obesity and hyperlipidemia.

INTRODUCTION

Because of the rapid and marked change in life styles and dietary habits, chronic diseases have become major public health problems. In Taiwan, cardiovas-

cular disease is the third leading cause of mortality after neoplasm and cerebrovascular disease [1]. It is well known that elevated blood cholesterol, especially elevated low density lipoprotein cholesterol, is

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^b Abbreviations: TC, total cholesterol; TG, triglyceride; HDL, high density lipoprotein cholesterol; WLI, weight length index.

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an important risk factor for cardiovascular disease [2-3]. It is believed atherosclerosis, a precursor of cardiovascular disease, develops early in childhood [4]. Previous research showed that cholesterol levels could track well from childhood to adulthood [5-6].

Children are more obese today than in previous times [7]. Obesity acquired in childhood is a predictive factor of becoming obese in adulthood and is also a risk factor for development of coronary artery calcification [7-8]. Thus, obesity in childhood is considered one of the major critical public health problems in industrialized countries and Taiwan [7, 9-10]. Therefore, it is time to pay attention to the health status of the children in this country.

We studied body size and other factors while a comprehensive health examination among children was conducted in Taichung City in Taiwan. The prevalence of obesity and the association between obesity and hyperlipidemia among the children were demonstrated.

MATERIALS AND METHODS

In March 2000, 2011 children from the first grade of primary schools in Taichung City in Taiwan, whose age range was between 6 to 8, were examined during periodic comprehensive health examination. No sampling method is needed.

Blood pressure was measured by a mercury sphygmomanometer in the sitting position. Weight and height were measured. Blood samples were obtained in the morning after a 12-hour overnight fast. A number of biochemical markers, such as total cholesterol (TC)^c, triglyceride (TG) and high density lipoprotein cholesterol (HDL) were analyzed by a biochemical autoanalyser (Hitachi-735, Japan) at the Department of Clinical Laboratory of China Medical College Hospital within 4 hours of collection. Low density lipopro-

tein cholesterol (LDL) was calculated by formula suggested by Friedewald et al.: $LDL = TC - (HDL + TG/5)$ [11].

Weight-length index (WLI) was measured as follows: $[\text{weight (kg)} \div \text{height (cm)}] \div [50 \text{ percentiles weight} \div 50 \text{ percentiles height}]$. $WLI \geq 1.2$ was defined as obesity, $1.1 \leq WLI < 1.2$ as overweight, $0.9 \leq WLI < 1.1$ as normal and $WLI < 0.9$ as underweight [12]. Hypercholesterolemia was defined as total cholesterol ≥ 170 mg/dl and hypertriglyceridemia was defined as triglyceride ≥ 150 mg/dl [13]. Abnormal HDL and abnormal LDL values were defined as the HDL < 35 mg/dl and LDL ≥ 110 mg/dl, respectively [13]. Subjects were considered to have hypertension if the average of the three readings exceeded 140 mmHg systolically and/or 90 mmHg diastolically [14].

The statistical analysis was performed by the aid of a SAS package (Version 6.12, SAS Institute, Inc., Cary, North Carolina). The methods of statistical analysis applied in this study were t test, chi-square analysis and multivariate logistic regression. Statistical significance was defined as p value less than 0.05.

RESULTS

There were 1057 boys (52.56 percent) and 954 girls (47.44 percent) in this study. The mean age was 7.27 ± 0.46 years. The mean weight was 24.97 ± 4.84 kg. The mean height was 121.76 ± 5.25 cm. The 50 percentile weight was 24.8 kg and the 50 percentile height was 122 cm in boys. The 50 percentile weight was 23.2 kg and the 50 percentile height was 121 cm in girls.

In Figure 1, the proportion of overweight was 11.07 percent in boys and 11.64 percent in girls. The proportion of obesity was 14.19 percent in boys and 12.89 percent in girls.

The results of chi-square analysis for obesity are shown in Table 1. The significant related factors of obesity were gender,

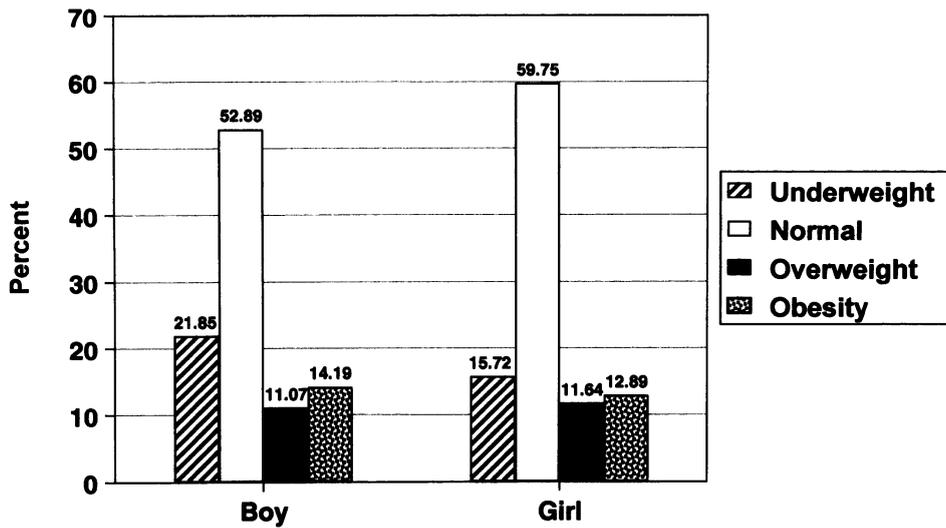


Figure 1. Body status among children by weight-length index (WLI).

WLI = [weight (kg) ÷ height (cm)] ÷ [50 percentile weight ÷ 50 percentile height].

Table 1. Correlates of obesity among the children by chi-square analysis.

Variable	Total number	Obesity number (%)	P value
Gender:			
Boy	1057	150 (14.19)	.002
Girl	954	123 (12.89)	
Hypertension:			
No	1971	265 (13.44)	.392
Yes	40	8 (20.00)	
Total cholesterol ≥ 170 (mg/dl):			
No	1053	135 (12.82)	.044
Yes	958	138 (14.41)	
Triglyceride ≥ 150 (mg/dl):			
No	2000	268 (13.40)	.019
Yes	11	5 (45.45)	
LDL ≥ 110 (mg/dl):			
No	1433	173 (12.07)	.005
Yes	578	100 (17.30)	
HDL < 35 (mg/dl):			
No	1990	267 (13.42)	.034
Yes	21	6 (28.57)	

LDL: Low density lipoprotein cholesterol

HDL: High density lipoprotein cholesterol

hypercholesterolemia, hypertriglyceridemia, abnormal HDL and abnormal LDL values.

The results of multivariate logistic regression for obesity are shown in Table 2. Overweight children were more likely to have abnormal HDL value than normal weight children (odds ratio [OR] = 3.36, 95 percent confidence interval [CI] = 1.14-9.91; $p < 0.05$). Obese children were more likely to have hypertriglyceridemia than normal weight children (OR = 5.67; 95 percent CI = 1.63-19.72; $p < 0.01$). Obese children were more likely to have abnormal LDL value than normal weight children (OR = 1.55; 95 percent CI = 1.18-2.04; $p < 0.01$). Obese children were more likely to have abnormal HDL value than normal weight children (OR = 3.39; 95 percent CI = 1.22-9.41; $p < 0.05$).

DISCUSSION

Obesity is characterized by an excess of fat tissue relative to lean body mass [10].

It is sometimes difficult to measure body fat. Thus, definition of obesity based on weight and height is usually used in clinical practice [10]. Body mass index (BMI: $\text{weight [kg]} \div \text{height [m]}^2$) is one indirect method to detect body fat. It is widely used in adults and has been established as a widespread agreement in standard definition for adult obesity [15, 16]. However, in Mulligan's report, BMI is harder to interpret in children than adults [17]. Thus, BMI cannot provide a standard definition for childhood obesity in clinical practice [17]. On the other hand, weight-length index is a simple, accurate method and used worldwide in evaluation of child obesity [12, 18]. That is why our study used weight-length index, not BMI, for evaluation of child obesity.

In Liu's report in 1996, the prevalence of obesity was 15.80 percent in boys and 12.40 percent in girls [19]. The sample

was also from the first grade of primary schools in Taichung City. In our current report, the prevalence of obesity was 14.19 percent in boys and 12.89 percent in girls. Although the prevalence of obesity did not seem to increase, it was still high. Obesity in childhood will persist into adult life, which has been known as a risk factor for chronic disease [20]. In Serdula's report, 42 to 63 percent of obese school-age children would become obese adults [21]. Obesity in adult life was associated with several chronic disorders, including coronary artery disease, hypertension, dyslipidemia, diabetes mellitus, gallbladder disease, osteoarthritis, some cancers, and increased mortality [8]. In Mokdad's report, an estimated 300,000 US adults die of causes attributable to obesity each year [22]. Thus, early and appropriate intervention to control and prevent childhood obesity might be warranted.

The combination of high serum triglyceride, small low-density lipoprotein cholesterol particles, and a reduction in high-density lipoprotein cholesterol levels has been identified as an atherogenic lipoprotein phenotype, or lipid triad [23]. They were all risk factors for cardiovascular disease [2, 3, 24]. In our current report, overweight was associated with low level of high density lipoprotein cholesterol. Obesity was associated with hypertriglyceridemia, a high level of low density lipoprotein cholesterol and a low level of high density lipoprotein cholesterol. That is, overweight and obesity were associated with hyperlipidemia in children. However, our study was only a cross-sectional study. It had fundamental weakpoint and inherent limitation. Therefore, the cause and effect issue between obesity and hyperlipidemia was not adequately discussed in our study. This might need further survey in the future.

In conclusion, the prevalence of overweight and obesity was high in children. Early and appropriate intervention for

Table 2. Results of multivariate logistic regression for obesity among children.

Variable	Hypertension OR (95%CI)	Total cholesterol ≥170 mg/dl OR (95%CI)	Triglyceride ≥150 mg/dl OR (95%CI)	LDL ≥110 mg/dl OR (95%CI)	HDL < 35 mg/dl OR (95%CI)
Sex (boy as reference):					
Girl	1.12 (0.60-2.09)	1.28 (1.07-1.53)**	1.38 (0.42-4.56)	1.36 (1.12-1.65)**	1.24(0.52-2.93)
WLI (normal as reference):					
Overweight	0.94 (0.33-2.72)	0.80 (0.61-1.07)	1.32 (0.15-11.37)	1.06 (0.78-1.44)	3.36 (1.14-9.91)*
Obesity	1.60 (0.72-3.56)	1.12 (0.87-1.45)	5.67 (1.63-19.72)**	1.55 (1.18-2.04)**	3.39 (1.22-9.41)*

*p < 0.05; ** p < 0.01.

OR: odds ratio; 95%CI: 95% confidence interval.

childhood obesity might be warranted. Overweight and obesity were associated with hyperlipidemia in children. The cause and effect issue between obesity and hyperlipidemia might need further survey.

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